

Application No. 09/476,910  
Response to Office Action

Customer No. 01933

Listing of Claims:

1. (Currently Amended) An image processing apparatus for  
~~assuming a characteristic of a virtual image sensing optical~~  
~~system, and applying a blur effect corresponding to a preset~~  
~~in focus state to a captured image,~~ comprising:

5 an image input unit for capturing image information  
including distance information to each portion of an object to be  
photographed;

a parameter input unit for inputting a parameter from which  
an effective aperture and focal length of the an assumed image  
10 sensing optical system can be derived;

an in-focal ~~point~~ point position designation unit for  
designating an in-focal ~~point~~ point position of the assumed image  
sensing optical system;

15 a blur state calculation unit for calculating a blur state  
from the distance information input by said image input unit, the  
in-focal ~~point~~ point position designated by said in-focal ~~point~~  
point position designation unit, and the parameter input by said  
parameter input unit; and

20 an image processing unit for applying ~~the~~ a blur effect to  
the image input by said image input unit in correspondence with  
the blur state calculated by said blur state calculation unit;

wherein the in-focal point position designated by said in-  
focal point position designation unit is determined using the

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25 distance information included in the image information, based on  
a position which is designated by a user in an image  
corresponding to the image information.

Claims 2 and 3 (Canceled).

4. (Currently Amended) An image processing apparatus for  
~~assuming a characteristic of a virtual image sensing optical~~  
~~system, and applying a blur effect corresponding to an in focus~~  
~~state to a captured image, comprising:~~

5 an image input unit for capturing image information  
including distance information to each portion of an object to be  
photographed;

10 a parameter input unit for inputting a parameter from which  
an effective aperture and focal length of ~~the~~ an assumed image  
sensing optical system can be derived;

an in-focal ~~point~~ point position designation unit for  
designating an in-focal ~~point~~ point position of the assumed image  
sensing optical system;

15 a confusion circle calculation unit for calculating a  
confusion circle from the distance information input by said  
image input unit, the in-focal ~~point~~ point position designated by  
said in-focal ~~point~~ point position designation unit, and the  
parameter input by said parameter input unit;

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20 a blur state calculation unit for calculating a blur state  
using a point spread function (~~PSF~~) within a range corresponding  
to a size of the confusion circle calculated by said confusion  
circle calculation unit; and

25 an image processing unit for applying ~~the~~ a blur effect to  
the image input by said image input unit in correspondence with  
the blur state calculated by said blur state calculation unit;

wherein the in-focal point position designated by said in-  
focal point position designation unit is determined using the  
distance information included in the image information, based on  
a position which is designated by a user in an image  
30 corresponding to the image information.

5. (Currently Amended) An image processing method ~~of~~  
~~assuming a characteristic of a virtual image sensing optical~~  
~~system, and applying a blur effect corresponding to a preset~~  
~~in-focus state to a captured image, comprising the steps of:~~

5 capturing image information including distance information  
to each portion of an object to be photographed;

inputting a parameter capable of deriving an effective  
aperture and focal length of the an assumed image sensing optical  
system;

10 designating an in-focal ~~pint~~ point position of the assumed  
image sensing optical system;

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calculating a blur state from the input distance information, the designated in-focal ~~point~~ point position, and the input parameter; and

15 applying ~~the~~ a blur effect to the input image in correspondence with the calculated blur state;

wherein the in-focal point position designated by said in-focal point position designation unit is determined using the distance information included in the image information, based on  
20 a position which is designated by a user in an image corresponding to the image information.

6. (Currently Amended) An image processing method of ~~assuming a characteristic of a virtual image sensing optical system, and applying a blur effect corresponding to an in-focus state to a captured image, comprising the steps of:~~

5 capturing image information including distance information to each portion of an object to be photographed;

inputting a parameter from which an effective aperture and focal length of ~~the~~ an assumed image sensing optical system can be derived;

10 designating an in-focal ~~point~~ point position of the assumed image sensing optical system;

calculating a confusion circle from the input distance information, the designated in-focal ~~point~~ point position, and the input parameter;

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15 calculating a blur state using a point spread function (PSF)  
within a range corresponding to a size of the calculated  
confusion circle; and

applying ~~the~~ a blur effect to the input image in  
correspondence with the calculated blur state;

20 wherein the in-focal point position designated by said in-  
focal point position designation unit is determined using the  
distance information included in the image information, based on  
a position in an image which is designated by a user.

Claim 7 (Canceled).

8. (Currently Amended) ~~An article of manufacture~~  
~~comprising: a~~ A computer-readable storage medium having  
computer-readable program code means stored thereon ~~to assume a~~  
~~characteristic of a virtual image sensing optical system and~~  
5 ~~apply a blur effect corresponding to a preset in-focus state to a~~  
~~captured image in an image processing apparatus, said~~  
computer-readable program code means comprising:

first computer-readable program means for providing a  
computer with a function of capturing image information including  
10 distance information to each portion of an object to be  
photographed;

second computer-readable program means for providing the  
computer with a function of inputting a parameter from which an

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effective aperture and focal length of the an assumed image  
15 sensing optical system can be derived;

third computer-readable program means for providing the  
computer with a function of designating an in-focal print point  
position of the assumed image sensing optical system;

fourth computer-readable program means for providing the  
20 computer with a function of calculating a blur state from the  
input distance information, the designated in-focal print point  
position, and the input parameter; and

fifth computer-readable program means for providing the  
computer with a function of applying the a blur effect to the  
25 input image in correspondence with the calculated blur state;

wherein the in-focal point position designated by said in-  
focal point position designation unit is determined using the  
distance information included in the image information, based on  
a position which is designated by a user in an image  
30 corresponding to the image information.

9. (Currently Amended) ~~An article of manufacture~~  
~~comprising: a~~ A computer-readable storage medium having  
computer-readable program code means stored thereon ~~to assume a~~  
~~characteristic of a virtual image sensing optical system and~~  
5 ~~apply a blur effect corresponding to an in-focus state to a~~  
~~captured image in an image processing apparatus, said~~  
computer-readable program code means comprising:

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first computer-readable program means for providing a  
computer with a function of capturing image information including  
10 distance information to each portion of an object to be  
photographed;

second computer-readable program means for providing the  
computer with a function of inputting a parameter from which an  
effective aperture and focal length of the an assumed image  
15 sensing optical system can be derived;

third computer-readable program means for providing the  
computer with a function of designating an in-focal point point  
position of the assumed image sensing optical system;

fourth computer-readable program means for providing the  
20 computer with a function of calculating a confusion circle from  
the input distance information, the designated in-focal point  
point position, and the input parameter;

fifth computer-readable program means for providing the  
computer with a function of calculating a blur state using a  
25 point spread function (PSF) within a range corresponding to a  
size of the calculated confusion circle; and

sixth computer-readable program means for providing the  
computer with a function of applying the a blur effect to the  
input image in correspondence with the calculated blur state;

30 wherein the in-focal point position designated by said in-  
focal point position designation unit is determined using the  
distance information included in the image information, based on

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a position which is designated by a user in an image  
corresponding to the image information.

Claim 10 (Canceled).

11. (Currently Amended) An image processing apparatus  
comprising:

means for inputting image data including depth information;

means for setting a parameter for expressing a lens

5 characteristic;

means for setting any one of a focal length, F-number, field  
angle, and effective aperture;

means for setting a distance ~~for adjusting a~~ in focus;

means for calculating expression of an image texture

10 including a blur from the virtual camera setting values and the  
depth information of the image; and

means for storing a calculation result in a memory

wherein an in-focal point position is determined using the  
depth information included in the image data based on a position  
15 designated by a user in an image corresponding to the image data.

12. (Original) An apparatus according to claim 11, further  
comprising means for inputting an image having depth information  
in units of pixels of a two-dimensional image.



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13. (Currently Amended) An apparatus according to  
claim 11, wherein a blur function is a point spread function  
(PSF) calculated in units of pixels from the focal length of a  
lens, the F-number or aperture, the an object distance, and the  
5 depth information of the image data.

14. (Currently Amended) An apparatus according to  
claim 11, wherein a blur function has a variable function shape,  
and is one of a concave function or and a convex function  
determined by a focal ~~point~~ point position and an object distance  
to be calculated.

15. (Currently Amended) An apparatus according to  
claim 11, wherein ~~a user can freely change, with a volume,~~ the  
F-number and a focal ~~point~~ point position designated by the user  
are adapted to be changeable by the user with a sliding switch,  
5 and wherein a calculation result using a thumbnail image obtained  
by thinning out an input image is displayed to interactively  
obtain a confirmable parameter setting.

Claim 16 (Canceled).

17. (Currently Amended) An apparatus according to  
claim 11, wherein ~~a user freely changes the F-number with a~~  
volume is adapted to be changeable by the user with a sliding

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5 ~~switch~~ while ~~designating the user designates~~ a focal ~~pint point~~ position on a designated window, and wherein a calculation result using a thumbnail image obtained by thinning out an input image is displayed to interactively obtain a parameter setting ~~capable of confirming which is adapted to confirm~~ designation of the focal ~~pint point~~ position and the F-number.

18. (Currently Amended) An apparatus according to claim 11, wherein ~~a user can change~~ a zoom ratio is adapted to be changed by the user by changing an f-number.

5 19. (Currently Amended) An apparatus according to claim 11, wherein a central point of a zoom and a position to get into focus are set in setting a zoom ratio, and wherein central coordinates of the zoom and depth information of the central point are used to one of calculate a blur state and an enlargement on a window and ~~a blur state or~~ to interactively determine a parameter.

20. (Original) An apparatus according to claim 19, wherein an outer frame in an area to be enlarged and displayed without changing a display ratio is displayed in setting the zoom ratio.

21. (Currently Amended) An apparatus according to claim 11, wherein a window is enlarged based on central

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coordinates of a zoom designated by a user, a focal ~~pint~~ point  
position on the window is designated to determine the focal ~~pint~~  
5 point position, the F-number is freely changed with a ~~volume~~  
sliding switch, and a calculation result using a thumbnail image  
obtained by thinning out an input image is displayed to  
interactively obtain a parameter setting ~~capable of confirming~~  
which is adapted to confirm designation of a central position of  
10 the field angle, a zoom ratio, and the F-number.

22. (Original) An apparatus according to claim 11, wherein  
a blur state is expressed using influence of coma which changes  
depending on a distance and azimuth from a center of an image.

23. (Original) An apparatus according to claim 11, wherein  
an asymmetrical point spread function is calculated for coma  
using a blur function obtained by shifting a central position of  
a radius of a confusion circle in accordance with a distance from  
5 a central position of an image.

Claim 24 (Canceled).

25. (Currently Amended) An apparatus according to  
claim 11, wherein a range  $d-\Delta$  from  $d$  on a point spread function  
for a radius ( $d$ ) of a symmetrical confusion circle is set as a

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chromatic aberration influence range, and one of red aberration  
5 ~~or~~ and blue aberration is applied.

Claim 26 (Canceled).

27. (Currently Amended) An apparatus according to  
claim 11, wherein one of a blue range ~~or~~ and a red range of a  
color characteristic at not less than a given distance is one of  
emphasized ~~or~~ and decreased.

28. (Currently Amended) An apparatus according to  
claim 11, further comprising means for inputting, as a set of  
units, depth information and image information in units of one of  
pixels ~~or~~ and areas for each object.

29. (Currently Amended) An apparatus according to  
claim 11, wherein an input image ~~is~~ comprises a set of objects  
having a predetermined distance in units of ~~not pixels but~~ sets  
of objects and not in units of pixels.